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TESTS FOR MAGNETIC PROPERTIES OF FERRITE AERIAL RODS

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TESTS FOR MAGNETIC PROPERTIES OF FERRITE AERIAL RODS

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Indian Standard

TESTS FOR MAGNETIC PROPERTIES OF FERRITE AERIAL RODS

0. FOREWORD

0.1 This Indian Standrad was adopted by the Indian Standards Institution on 26 August 1981, after the draft finalized by the Magnetic Components and Ferrite Materials Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 It has been the practice that the measuring coils and comparison rods for evaluating the magnetic properties of ferrite aerial rods are exchanged between the manufacturers and the users. However, the exchange has not always been possible and also the comparison rods of different manufacturers could not be interchanged. The reason for this, besides the lack of standardization, is that the correlation of the values obtained with measuring coils is rather uncertain. This is especially so in the case of quality factor *Q*.

0.3 The standardization of the test coils and test methods for aerial rods having substantially circular cross section has been undertaken so that the magnetic properties, particularly the inductance and the quality factor, may be measured and specified by all manufacturers and users on a uniform basis. This would facilitate comparison of characteristics of different rods.

0.4 Dimensions of ferrite aerial rods are covered in IS : 1176-1969*.

0.5 In MW and or SW radio receivers where the frequency range extends approximately up to 25 MHz use of single ferrite rod for both MW and SW will result in poorer performance with respect to sensitivity and signal to noise ratio on medium frequency range. In such cases, use of ferrite rod up to 5 MHz and loop aerial for frequencies above 5 MHz would be the normal practice. However, in receivers with the limited size where it is not possible to use the loop aerial, such operation necessitates the use of two different coils for measurement of *Q* at 5 MHz and 25 MHz instead of the coil for *Q* measurement at 25 MHz because it restricts the measurement of *Q* at 5 MHz in view of very high tuning capacitance required.

0.6 The test coils have been so specified that the indicated electrical properties may be attained without difficulty with reasonably careful production.

---

*Dimensions for aerial rods and slabs of ferromagnetic materials.

0.6.1 For the measurement of inductance L, the coil with 97 turns has been specified. The inductance value may be determined by the use of a measuring bridge.

0.6.2 Due to its longer length the coil with 97 turns is suitable for use with rods of not only 10 mm diameter but also those of 8 mm diameter.

0.7 The high permeability ferrite material for aerial rods require low measurement voltages for test (*see* **4.1**) so that induction in the aerial rod due to the measuring voltage does not increase with consequential increase of permeability.

0.7.1 The test coils specified are suitable for use on tolerance measuring bridges.

0.8 This standard covers the tests laid down earlier in IS : 7431 (Part I) - 1974* and IS : 7431 (Part II)-1976*, and therefore, supersedes the two.

0.9 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2 - 1960†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers the methods of testing of magnetic properties (inductance L and quality factor Q) of ferrite aerial rods having substantially circular cross-section and used in broadcast receivers for short and medium wave reception.

1.2 The inductance L and the quality factor Q are the inductance and quality factor of the combination of aerial rod and the specified measuring coil.

2. EXPLANATION OF TERMS

2.0 For the purpose of this standard, the following explanation of terms shall apply.

---

*Tests for magnetic properties of ferrite aerial rods:

Part I For long and medium wave receptions.
Part II For short wave reception.

†Rules for rounding off numerical values (*revised*).

2.1 Inductance, L — The inductance of a specified measuring coil placed on the aerial rod and is defined by the relation:

$$L = \mu_{app} L_0$$

where

μ_{app} = apparent permeability of the aerial rod, and

L_0 = inductance of the measuring coil without aerial rod.

2.2 Quality Factor, Q — The ratio of the reactance wLs to the total loss resistance Rs, when the impedance of the coil is represented by a series combination of reactance and a resistance, or the ratio of the total loss resistance R_p to the reactance ωL_p, when represented by a parallel connection. The reactance and resistance refer to a specified measuring coil placed on the aerial rod, and to a specified measuring frequency. It is defined by the relation:

$$Q = \frac{\omega Ls}{Rs} = \frac{R_p}{wL_p} = \frac{1}{\tan \delta}$$

where

ω = angular frequency = $2\pi f$.

3. MEASURING FREQUENCY

3.1 Inductance, L — The measuring frequency for the inductance of the aerial rods shall be as given in Table 1.

TABLE 1 INDUCTANCE MEASURING FREQUENCY

(*Clauses* 3.1 *and* 6.3)

BAND	COIL	FREQUENCY
MW	SP 25	10 kHz
MW and SW	SP 49	1·5 MHz
SW	SP 13	5 MHz
	SP 4	15 & 25 MHz

3.2 Quality Factor, Q — The measurement frequency for the quality factor Q of aerial rods shall be as given in Table 2.

4. MEASURING VOLTAGE

4.1 The rms value of the voltage applied to the measuring coil for the measurement of the inductance L shall not exceed 100 mV.

NOTE 1 — This limit has been so chosen that the inductance L in the case of ferrites in common use for making aerial rods does not change by more than 0·3 percent due to the flux density in the aerial rod.

NOTE 2 — The measuring voltage is directly proportional to the frequency.

4.2 The rms value of the voltage applied to the measuring coil for the measurement of quality factor Q shall not exceed 2 V.

TABLE 2 QUALITY FACTOR MEASURING FREQUENCY

(*Clauses* 3.2 *and* 6.4)

BAND	COIL	FREQUENCY
MW	SP 25	1·5 MHz
MW and SW	SP 49	1·5 MHz
	SP 13	5 MHz
	SP 5	15 MHz
SW	SP 4	25 MHz

5. MEASURING COILS

5.1 The coils for measurement of inductance L and quality factor Q shall be as specified in Tables 1 and 2, respectively.

5.1.1 Both the measuring coils are suitable for aerial rods with a diameter of 8 or 10 mm.

5.2 Dimensions of the measuring coils without aerial rods shall be as given in Fig. 1.

5.3 The construction of the fixture for the measuring coil shall be according to the specified dimensions (*see* Fig. 2).

NOTE 1 — Pin separation 'e' should be minimum 24 mm and maximum 32 mm to fit the measuring equipment.

NOTE 2 — The ceramic bobbin used should conform to Grade VIII of IS : 6659-1971*.

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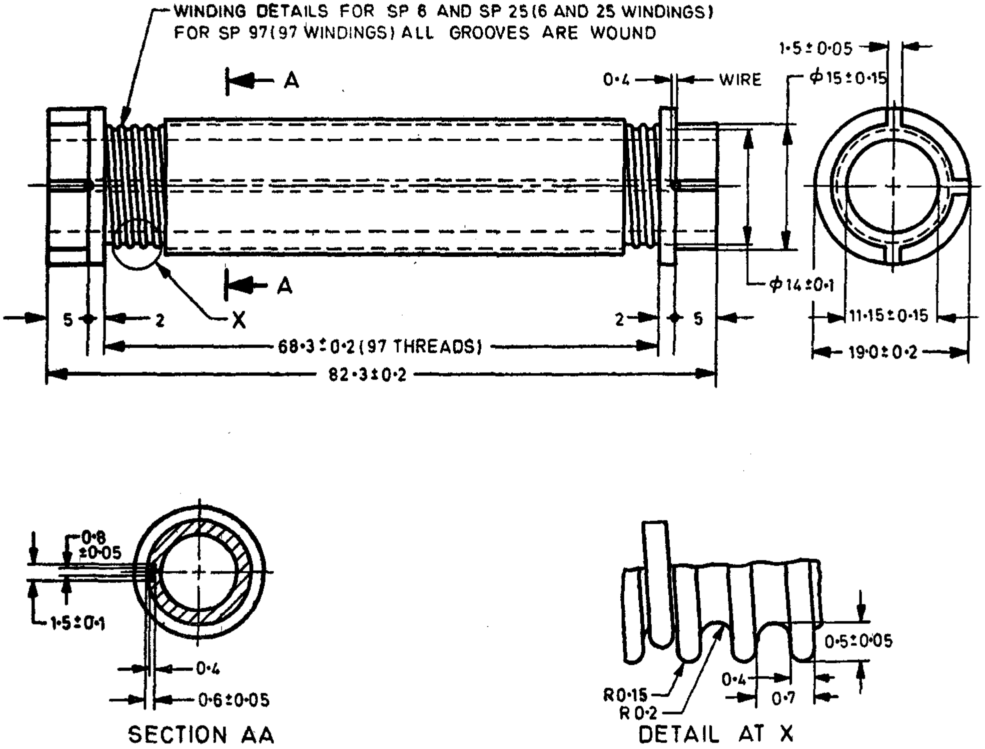
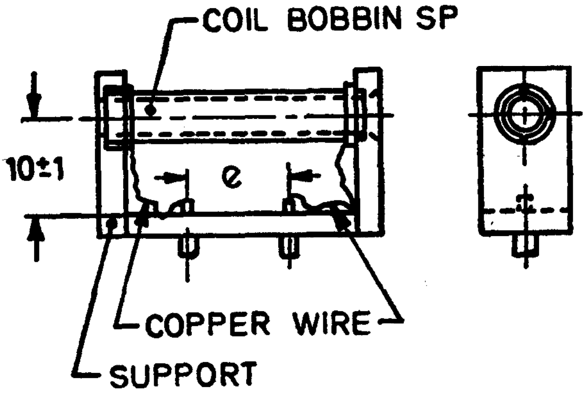
*Specification for ceramics for telecommunication and allied purposes.



All dimensions in millimetres.

FIG. 1 WINDING DETAILS



All dimensions in millimetres.

FIG. 2 EXAMPLE OF FIXTURE OF THE COIL FORMER

5.4 The two measuring coils are made with coil formers made of low-loss material (*see* Note) which is resistant to abrasion and has a Vicat softening point not less than 90°C, of polycarbonate.

NOTE — For the purpose of this standard, a material with tan δ not exceeding 150×10^{-4} measured at 1 MHz in accordance with IS : 4486 - 1967* may be considered to be low-loss material.

5.4.1 The *Q*-measuring coil former should be made of ceramic material of Grade VIII which has very low dielectric losses (*see* Fig. 2).

5.5 For the measurement of quality factor *Q*, two coils are provided, one coil having 6 turns for measurement at 25 MHz and other having 25 turns for measurements at 5 MHz. These coils are wound on the same coil former as coil with 97 turns. The windings are symmetrically placed in the former in such a way that for 6 turns, 8 turns are left empty at both ends and 15 turns between consecutive turns; similarly 30 and 3 turns are left empty at end and between consecutive turns in case of 25 turns winding.

5.5.1 For measurement at MW, 7/0·063 mm, copper wire with Litz construction may be used for winding.

5.5.2 For measurement at SW, 0·50 mm, super enamelled copper wire may be used for winding.

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*Recommended methods for the determination of the permitivity and dielectric dissipation factor of electrical insulating materials at power, audio and radio frequencies including metre wavelengths.

6. TEST PROCEDURE

6.1 Test Temperature — The inductance *L* and the quality factor *Q* may be measured at a temperature ranging from 15 to 35°C. In case of doubt the measurement shall be made at a temperature of 27 ± 2°C. The aerial rods to be tested shall be exposed to the test temperature for at least 3 hours before measurement.

6.2 Aerial rods should be tested with the measuring coil placed centrally with respect to length of the rod and coaxially with the rod. The permissible deviation of the centre of the rod from the centre of the coil is 1·5 percent of the length of the rod.

6.2.1 Magnetic parts and larger metallic parts other than the test instrument itself shall not be placed within a distance of 250 mm from the aerial rod.

6.3 Measurement of Inductance, L — The inaccuracy of the measurement equipment used for the inductance measurement shall be better than 0·5 percent. The inductance *L* is measured with the coil (as specified in Table 1) placed on the aerial rod. It is expressed in μH. Distance of coil placement from end of the rod shall be 33 percent of the total length.

6.4 Measurement of Quality Factor, Q — The quality factor *Q* shall be measured with the measuring coil (as specified in Table 2) placed at a distance of 33 percent of total length from the end on the aerial rod.

7. TOLERANCE ON THE VALUE OF INDUCTANCE, L

7.1 The value of inductance *L* of the aerial rod obtained with the specified measuring coil shall be agreed to between the manufacturer and the user. The permissible tolerance on the value shall be as specified in Table 3.

TABLE 3 PERMISSIBLE TOLERANCE ON THE INDUCTANCE VALUE

NOMINAL LENGTH OF AERIAL ROD	PERMISSIBLE VARIATION OF INDUCTANCE, *L* (PERCENT)
(1)	(2)
Below 90	Under Consideration
90 to 140	± 6
140 to 170	± 7
170 to 200	± 8
Over 200	± 10

8. TOLERANCE ON QUALITY FACTOR, Q

8.1 The value of the quality factor *Q* of the aerial rod obtained with the specified measuring coil shall be agreed to between the manufacturer and the user. The value of the quality factor shall be not less than the specified minimum.